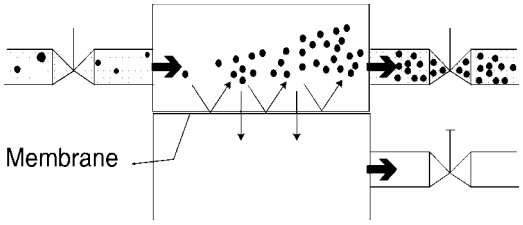
Applied Technology: Membrane



Credit: Ontario Hydro Research Division

Concept

Membranes selectively filter gases or liquids in solutions or mixtures into their different components. Membranes generally use thin plastic tubes or sheets, bundled into a metal vessel similar to a heat exchanger. Other membrane types, including porous metals and ceramics, are also being developed. The membrane micropores are sized to allow some molecules and particles through while blocking others. Thus membranes are very application-specific, with their molecular structure tailored to the particular species to be separated. The "pressure" used to drive the selected species through the membrane can be mechanical (reverse osmosis, ultrafiltration, microfiltration, and gas permeation) for molecules or electrical (electrodialysis) for ions.

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Applications

- Wastewater purification for reuse
- Concentration of food liquids and proteins
- Desalting and deacidification of food
- Separation of organic chemicals, gas molecules (O_2, N_2), Cl_2 and caustic (chlor-alkali)
- Recovery of sizing, dye, and others in textile/leather and electrophoretic paint in metal fab
- Removal of trace gases in oil refinery, bacteria/viruses from biofluids, and alcohol from beer

Technologies Replaced

- Fuel fired distilling and evaporating
- Chemical wastewater treatment
- Chemical separation

Wastes Reduced

- Combustion products: COx, SOx, ROG, particulates
- Wastewater pollutants and treatment chemicals
- Hazardous Air Pollutants (HAPs) from thermal treatment of process emissions

Potential in Manufacturing

Indust	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*
Food	**20**	**HI**	Lumber	24	LOW	**Chem**	**28**	**HI**	Stone	32	LOW	Elect	36	MED
Tobac	21	MED	Furn	25	MED	Petrol	29	MED	Pmetal	33	MED	Transp	37	MED
Textile	**22**	**HI**	**Paper**	**26**	**HI**	Rubber	30	LOW	MetFab	34	MED	Instr	38	MED
Apparel	23	LOW	Printing	27	MED	Leather	31	MED	Mach	35	MED	Misc	39	MED

Credits: **: Dr. Philip Schmidt and Dr. F.T. Sparrow;**
Unimar Group, Ltd; The Electrification Council; Electric Power Research Institute

Membrane ***continued***

Technology Advantages

- Provides major reduction in overall energy use and associated emissions
- Suitable for temperature sensitive products
- High separation % (product purity)
- No boiling/freezing point limitations
- Mechanically simple, reliable, and easy to maintain.
- Compact size
- Low capital cost for low capacities

Technology Disadvantages

- Suitable membranes hard to find for some applications
- Some stream contaminants may damage membrane
- May not be suitable for pressure sensitive products
- Little economy of scale; may be uneconomic for large flows

Typical Costs

Capital Costs	O & M Costs	Potential Payback
Very application, size, and flow dependent. Typical Ultrafiltration costs: $600-$1200/m2 or $1-$3/liter flow.	Energy savings typically >90% over evaporative systems. Membrane replacement 1-6 years depending on type, application, and operating conditions.	1 - 3 years depending on application.

Installations

Case A - Conventional chemical treatment of oily wastewaters in a metal fab plant produces an oily sludge. The sludge must be stabilized before disposal and the water effluent must treated before discharge. Ultrafiltration systems directly produce water pure enough to be discharged with no post-treatment. The oil is concentrated (3-5% of the original stream volume) and can either be incinerated or reprocessed. Installed capital cost for a 40,000 liter/day system is around $100,000. Total operating cost is about $2.50/liter or a penny a gallon. And this assumes no credit for oil reuse or combustion as fuel. Energy requirements are about 400-600 kwh/day or 10-15 kwh per cubic meter flow, and operating labor requires about 7-10 hrs/week.

Case B - Reverse osmosis systems are now commonly used to reprocess rinse waters from metal galvanizing plants. The purification is effective enough to permit reuse in the process, eliminating treatment and disposal costs. More importantly, nickel and other valuable metals can be recovered, turning a liability (disposal of heavy-metal-contaminated wastewater) into an asset. Membranes typically last over 2 years. Paybacks of 2 months to 2 years have been reported based on the value of recovered metals alone.

Major Vendors

Membrane

A/G Technology Corp.
(Ultra and microfiltration)
101 Hampton Avenue
Needham, MA 02194
(800) 248-2535

Aqualytics
(electrodialysis)
7 Powder Horn Drive
Warren, NJ 07059
(908) 563-2800

Dedert Corporation
20000 Governors Dr.
Olympia Fields, IL 60461
(708) 747-7000

Graver Separations, Inc
(Micro, ultra, and nanofiltration)
200 Lake Drive
Glasgow, DE 19702
(302) 731-1700

Ionics, Inc.
5455 Garden Grove Blvd.
Westminster, CA 92683
(714) 893-1545

Koch Membrane Systems, Inc.
850 Main St
Wilmington, MA 01887
(800) 343-0499

Niro Hudson, Inc
1600 O'Keefe
Hudson, WI 54016
(715) 386-9371

Osmonics, Inc.
5951 Clearwater Dr.
Minnetonka, MN 55343
(612) 933-2277

This list of vendors of the indicated technology is not meant to be a complete or comprehensive listing. Mention of any product, process, service, or vendor in this publication is solely for educational purposes and should not be regarded as an endorsement by the authors or publishers.

Index to EPRI DOCUMENTS

Membrane

Special Publications

Osmonics Relative Membrane and Filtrate Size Chart

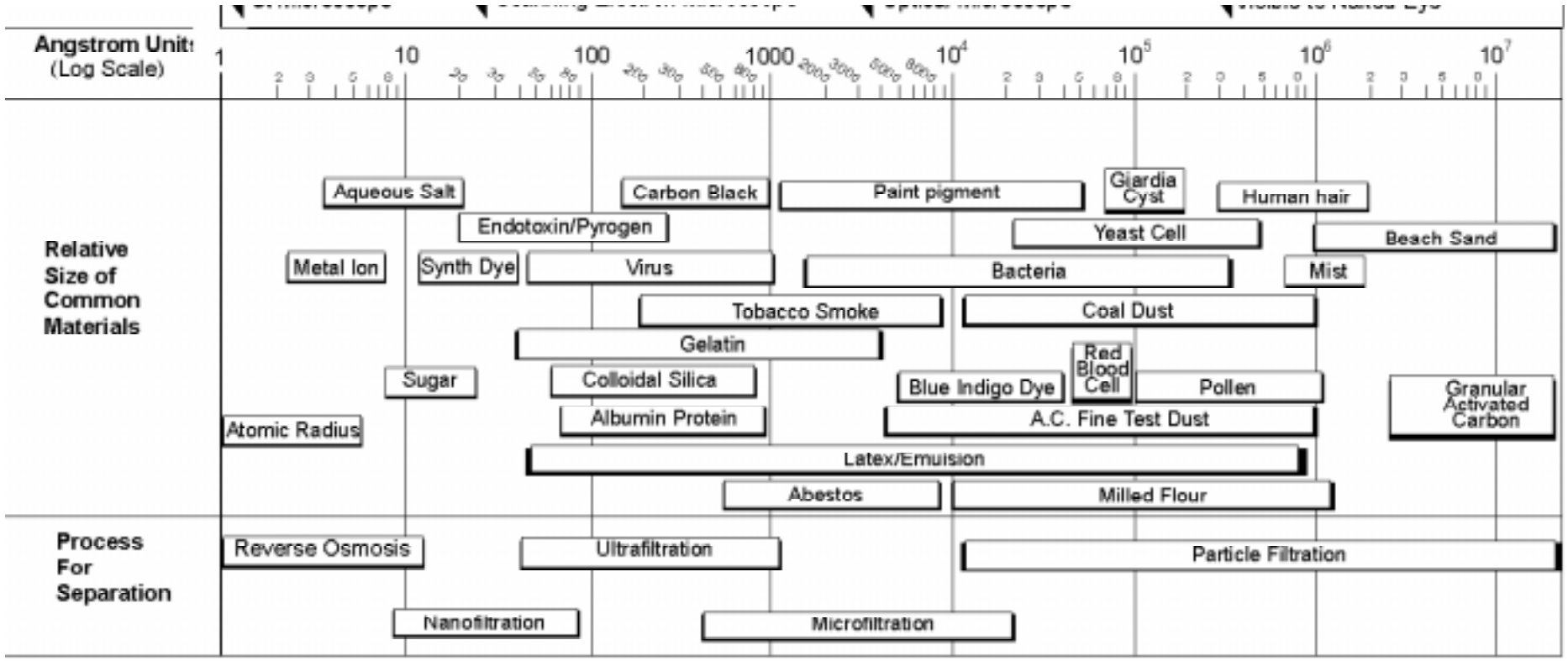
EPRI Publications

Membrane Separation in Food Processing, EPRI PIO TechApplication, Vol 3, No 1, 1991

Ultrafiltration in Food Processing, EPRI PIO TechApplication, Vol 4, No 6, 1992

Industrial Wastewater Minimization, EPRI TechCommentary, TC-107624, 1996

RELATIVE MEMBRANE AND FILTRATE SIZE CHART



Credit : Osmonics, Inc.

This information is designed to help you determine **potential** applications for the technology. You are encouraged to contact one of the listed vendors or a consultant for details and pricing.

This manual is not intended as a recommendation of any particular technology, process, or method. Mention of trade names, vendors, or commercial products do not constitute endorsement or recommendation for use. It is offered for educational and informational purposes and is advisory only.

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Developed with funding from the U.S. Environmental Protection Agency - Center for Environmental Research Information